AWP4 DC Bridge Amplifier for the MT95K2
Operation and Host Control Manual

Part Number 22834-030

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Introduction

The AWP4 is a 2-channel DC bridge amplifier for the MT95K2. It offers quarter, half and full bridge measurements with both voltage and current excitation. All controls for balance, sensitivity gauge factor and bridge configuration are controlled by front panel menu keys.

Description of Functions

Sensitivity (range) - This adjustment allows the user to choose a sensitivity with the encoder wheel.

Excitation - This allows the user to select either voltage (0 - 10V) or current (0 - 20mA) excitation, and use the encoder wheel to choose the level.

Gauge Factor - This allows the user to choose a gauge factor (GF). This value is defaulted to 2.000, but can be changed to suit a particular system.

Coarse Zero Balance - This is one of two user adjustments in order to manually zero balance a connected bridge. Coarse refers to the resolution of the adjustment.

Fine Zero Balance - This is the second adjustment that allows the user to balance a bridge. This provides the user with better resolution than coarse. It should be noted that both coarse and fine do not provide numeric reference to the user, changes can be seen on the chart.

Bridge Type - The user can select either full or half/quarter configurations.

Filter - This setup consists of type and frequency. The user can select low pass, notch or two types of mean filtering. Frequency for low pass and notch filtering is selected using the encoder wheel, and ranges from 5 to 990 Hz, in steps of 5 Hz.

Shunt - This is used to enable or disable a user provided shunt calibration resistor.

Auto Balance - This will automatically balance the bridge and place the baseline of the signal on the left edge, center, or right edge of the grid.

DC/GND and Filter ON/OFF - Selects DC or GND and turns filter on and off.

Auto Calibration - Compensates for internal gain error.

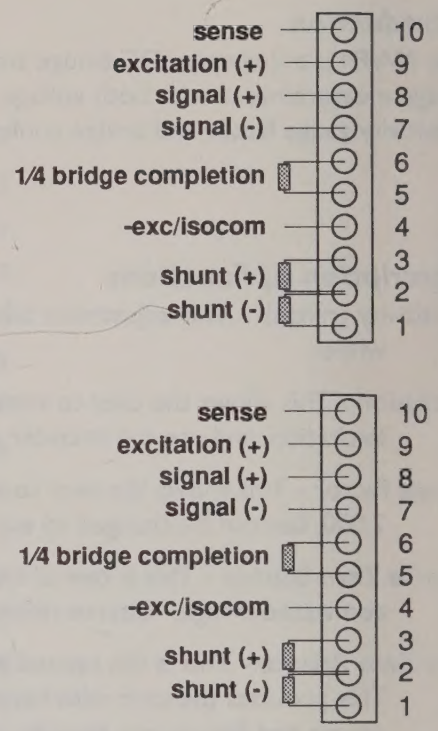
A description of the AWP4 bridge module

Connecting a transducer to the AWP4

transducer input connector

pin	function
1 and 2	external shunt resistor connection for negative calibration
3 and 2	external shunt resistor connection for positive calibration
4	- excitation (isolated common)
5 and 6	bridge completion resistor for 1/4 bridge application*
7	- signal
8	+ signal
9	+ excitation
10	sense

*The value of the dummy resistor must be equal to the gage resistance.



Using the module's front-panel controls

The AWP4 module provides front-panel controls for zero and gain adjustments, excitation voltage selection, and 1/4 bridge, 1/2 bridge, full bridge selection, gage factor, autobalance, shunt enable and filtering.

The paragraphs that follow discuss each of these setups.

AWP4 module and MT95K2 balance controls

NOTE

System balancing should always be done after an excitation voltage has been selected. Balance and sensitivity settings can be invalid if excitation is changed during operation.

Selecting the excitation voltage

1. Press the [Z/G] key, use INC and DEC to choose the correct channel
2. Choose EXCITE to select voltage or current excitation
3. Use the wheel to select the level of excitation

Selecting a bridge type

For 1/4 and 1/2 bridge applications, an internal half bridge is provided. The half bridge consists of two 1000 ohm dummy gages and is enabled by selecting the 1/2 or 1/4 bridge type. 1/4 bridge applications require the use of an external dummy resistor equivalent to the value of the active gage.

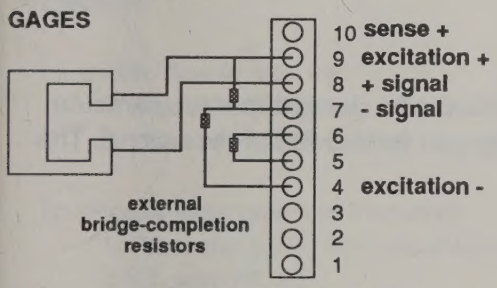
When the full bridge configuration is selected, the internal half bridge forms a quadrilateral with the external transducer.

See the typical wiring diagrams below.

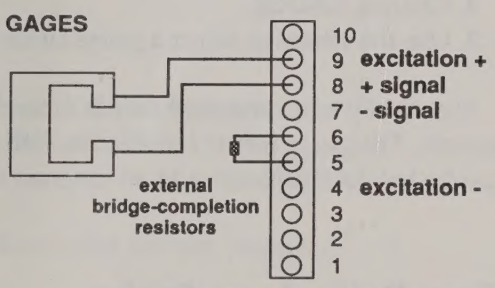
Bridge Type Selection

1. Press the [Z/G] key, use INC and DEC to choose the correct channel
2. Choose MORE
3. Choose Bridge Type
4. Select [1/2 or 1/4] or [FULL]

Quarter Bridge

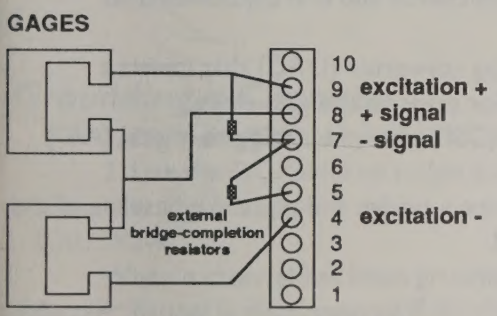


Bridge type set at full.

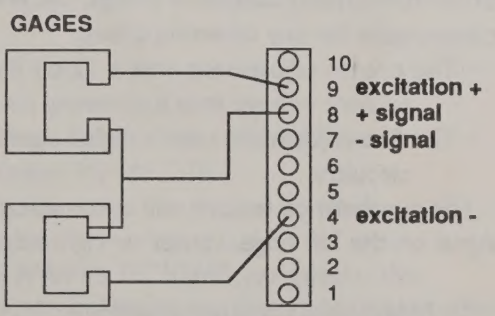


Internal bridge completion.
Bridge type set at 1/2 - 1/4.

Half Bridge

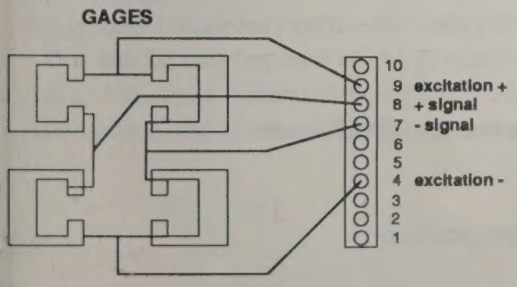


Bridge type set at full.

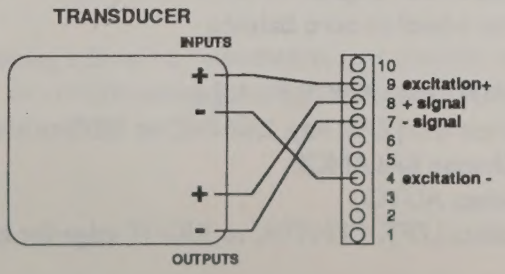


Internal bridge completion.
Bridge type set at 1/2 - 1/4.

Full Bridge



Bridge type set at full



Selecting a Sensitivity (Range)

1. Press the [Z/G] key. Use INC or DEC to choose the correct channel
2. Choose SENS
3. Use the wheel to select a sensitivity

The AWP4 sensitivity settings are expressed in mV/V or mV/mA. The full scale (grid edge to grid edge) value is based on this sensitivity choice, assuming the maximum excitation voltage or current. For example, the 5mV/V sensivity setting results in a full scale value of 50 mV since the maximum voltage excitation is 10V.

Selecting a Gauge Factor

1. Press the [Z/G] key. Use INC or DEC to choose the correct channel
2. Choose GAUGE
3. Use the wheel to select a gauge factor

The AWP4 has a standard default factor of 2.000. This can be changed to suit a particular system. The gauge factor can also be used to modify the gain (sensitivity) of the channel. This can be helpful if calibrating to an external standard.

Zero Balancing a Bridge

The AWP4 has two methods for the user to balance a bridge: manually or automatically. In order to manually balance a bridge, the AWP4 has both coarse and fine adjustments to compensate for any inherent offset.

- The coarse adjustment uses a 12-bit digital-to-analog converter (DAC) that injects a balance voltage into a summing junction amplifier prior to the gain stage.
- The fine adjustment uses a digital signal processor (DSP) after the analog-to-digital (A/D) circuitry.

The autobalance feature will automatically zero balance a bridge and place the baseline of the signal on the left edge, center or right edge of the grid.

To MANUALLY balance a bridge

1. Press the [Z/G] key. Use INC or DEC to choose the correct channel
2. Choose BALANCE
3. Select COARSE or FINE
4. Use wheel to zero balance

To AUTOBALANCE a bridge

1. Press the [Z/G] key. Use INC or DEC to choose the correct channel
2. Choose BALANCE
3. Select AUTO
4. Select LEFT, CENTER, or RIGHT edge for baseline position

Auto-Calibrating a Channel

The AWP4 has a NIST traceable internal reference voltage that is used to calibrate a channel. This autocalibration will compensate for analog gain error.

1. Press the [Z/G] key. Use INC or DEC to choose the correct channel.
2. Choose MORE
3. Choose AUTOCAL
4. Choose START (or AUTOCAL ALL for all channels)

Filtering

The AWP4 utilizes DSP (digital signal processing) filtering for both lowpass and notch filtering. The cutoff or center frequency is programmable from 5 to 990 Hz, in steps of 5 Hz for lowpass and notch filtering. Mean #1 and Mean #2 have time constants of .05s and .25s, respectively.

To enable/disable filtering

1. Press the [Z/G] key. Use INC or DEC to choose the correct channel.
2. Use the FILTER softkey to toggle between ON and OFF

To select a filter type and frequency

1. Press the [Z/G] key, use INC or DEC to choose the correct channel.
2. Choose MORE
3. Choose SETUP FILTER
4. Select LOWPASS, NOTCH, MEAN #1, OR MEAN #2
5. Use the wheel to choose a cutoff (for lowpass) or center (for notch) frequency

Grounding a Channel

1. Press the [Z/G] key. Use INC or DEC to choose the correct channel.
2. Use the DC/GND to toggle between DC (signal in) and GND

CAUTION

When a channel has been grounded using the AWP4's DC/GND parameter, the selected channel is disconnected from the Bridge Module and the signal input line is connected to a local ground/zero reference potential.

When a channel is grounded the reference point on the baseline may vary from the null reference point of the channel with transducer. The baseline reference for ground only reflects the system (recorder) zero-reference point.

This can be used as part of the process of setting a baseline reference to any position on the chart. However, when balancing a transducer or compensating for offset using manual or autobalance, the selected AWP4 channel must always be set to DC.

Enabling a Shunt Calibration Resistor

1. Press the [Z/G] key. Use INC or DEC to choose the correct channel.
2. Choose MORE
3. Choose SETUP SHUNT
4. Choose ENABLE (or DISABLE after shunt calibration)

About shunt calibration

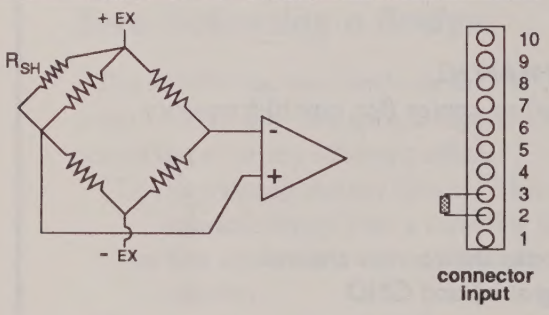
Shunt calibration is achieved by connecting a shunt resistor across an active gauge arm to simulate either compression (+CAL) or expansion (-CAL).

In 1/4 bridge applications, the shunt resistor must be across the external dummy resistor for -CAL.

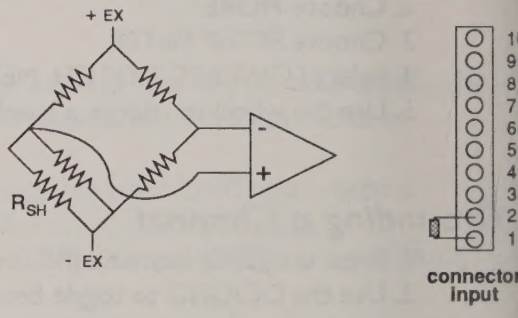
The reference shunt is activated only when the shunt resistor is enabled.

It is recommended that only one shunt resistor (shunt+ or shunt-) be connected. If two resistors are connected, they will not have any significant effect on the bridge. See the illustrations below.

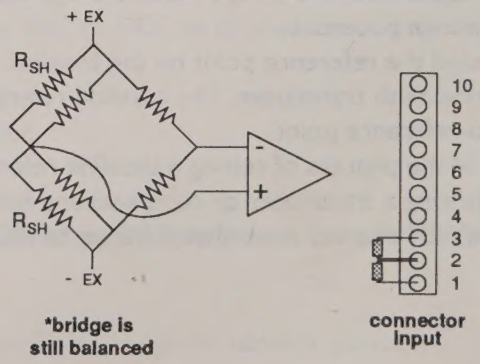
correct connection for CAL+



correct connection for CAL -



wrong shunt resistor connection



Host Control of the MT95K2

Host control of the MT95K2 is accomplished through groups of commands that enable you to operate the recorder and to set up your system by defining both the characteristics of the incoming data and the representation of that data on the chart and displays.

Command Structure

The MT95K2 recorder responds to a simple mnemonic-based set of commands. To instruct the recorder to enter or exit a mode or to perform a function, you send it a command from the host. A command is comprised of a header and parameters and is concluded by a message terminator.

COMMAND FORMAT: [XXXX] [n],[x] [*]
where XXXX represents the command header, n and x the parameters and * the terminator

Command Header: a four character device command for any function. The command header may be either upper of lower case characters; they are depicted as upper case throughout this manual.

Parameters: program data that completes the command string

Command Terminator: a line feed <lf> if control is via RS-232; an EOI pulse only or an EOI pulse and line feed if control is via GPIB.

Separators: a minimum of one space between the header and parameters, a comma between parameters

Queries

Host control of the MT95K2 recorder includes query capability, allowing the host computer to request current recorder settings while under host control through the RS-232 or IEEE-488 interface. As with the other host control commands, the query commands are simple mnemonic-based commands.

The full query request is comprised of the normal command header followed immediatly by a question mark, parameters (if any), and a concluding message terminator. A space is required after the question mark, and commands are required to separate parameters if there are more than one.

Input/Output Buffers

The MT95K2 maintains 256-character cyclic input and output buffers for commands to and responses from the recorder. The input buffer allows the MT95K2 to accept commands as rapidly as the host computer can send them until 256 bytes (characters) are read. At this point, the MT95K2 holds up the host until enough bytes are removed from the input buffer to allow communications to resume. The MT95K2 sends responses to host commands and queries to the output buffer for transfer to the host computer.

Establishing Host Control

Host control of the MT95K2 recorder can be established through either an RS-232 serial port or a GPIB (IEEE-488) port. Virturally all functions available through local (front panel) control of the MT95K2 are available through the host interface.

In addition to controlling operation of the recorder, the host computer can receive data from and transfer data to the recorder over the communications interface.

Each interface offers different advantages, which should be considered when selecting the interface you will use. The GPIB interface allows a number of IEEE-488 compatible devices on the same bus, each of which has its own address. Since GPIB is a parallel interface, transmission speed is much higher than when using the RS-232 serial interface. The RS-232 interface, however, can accomodate much longer distances without using repeaters or bus extenders.

Please refer to the complete MT95K2 Host Control manual for specific connection information.

Range: Host control command used to set the range

Command Header: [SRNG] [n], [x], [u][*]
Parameters: n is the channel '1' to '32'
x is the range string (see below)
u is units in V (mV/V) or mA (mV/mA), depending on mode

Acceptable Ranges

mV/V	mV/mA
0.250 mV	0.125 mA
0.300 mV to 1.00 mV in 0.10 mV steps	0.20 mA to 1.00 mA in 0.10 mA steps
2.00 mV to 10.00 mV in 1.00 mV steps	2.00 mA to 10.00 mA in 1.00 mA steps
15.00 mV to 100.00 mV in 5.00 mV steps	15.00 mA to 100.00 mA in 5.00 mA steps
110.00 mV to 500 mV in 10.00 mV steps	110.00 mA to 250 mA in 10.00 mA steps

The AWP4 must be set to the correct mode (mV/V or mV/mA) in order for the host to use the SRNG command for that mode.

Example:
SRNG 2, 250.00, mA<lf> sets channel 2 to the 250 mV/mA range

Query Header: [SRNG?] [n][*]
Parameters: n with channel number '1' to '32'
Responses: n, x, u as above (x is always 4 ASCII digits)

Signal/Ground: This command will change the GND status on the MT95K2 for any one of the analog channels. This may be switched to DC signal or to GND

Command Header: [SGND] [n],[x][*]
Parameters: n = channel number '1' to '32'
x = '0' for GND, '1' for DC (signal in)
Example: SGND 8,1<lf> for channel 8 to have signal

Query Header: [SGND?] [n][*]
Parameters: n with channel number '1' to '32'
Responses: n, x as above
Example: SGND?8<lf>
Example Response: '08, 1'<lf> Channel 8 is set to DC signal

Filter On/Off: Allows the host to turn a filter for each channel on or off.

Command Header: [SFIL] [n],[x][*]
Parameters: n with channel number '1' to '32'
x = '0' turn filter off, = '1' turn filter on
Example: SFIL 4,0<lf> Turn channel 4 filter off

Query Header [SFIL?] [n][*]
Parameters: n with channel number '1' to '32'
Responses: x as above
Example: SFIL? 4<lf>
Example Response: '04,0'<lf> filter is off on channel 4

Select Filter Type: This command allows the host to select lowpass, notch or mean filtering for the AWP4

Command Header: [FTYP][n],[x][*]
Parameters: n is the channel number '1' to '32'
x = '0' for lowpass filter, = '1' for notch filter, = '2' for Mean #1,
= '3' for Mean #2
Example: FTYP 2,1<lf> selects notch filtering for channel 4

Query Header: [FTYP?][n][*]
Parameters: n is the channel number '1' to '32'
Response: x as above
Example: FTYP? 4<lf>
Example Response: '04, 1' <lf> indicates notch filtering for channel 4

Select cutoff or center frequency: Allows the host to select the cutoff or center frequency. If the filter type is lowpass, the cutoff frequency will be selected. If the type is notch, the center frequency will be selected. The range of allowed frequencies are 5 through 990 Hz, in increments of 5 Hz.

Command Header: [FFRQ][n],[x][*]
Parameters: n is the channel number '1' to '32'
x = frequency (5 - 990Hz)
Example: FFRQ 2,60 <lf> selects 60 Hz frequency for channel 2

Query Header: [FFRQ?][n][*]
Parameters: n with channel number '1' to '32'
Response: x as above
Example: FFRQ? 2 <lf>
Example Response: '02,60' <lf> Indicates 60 Hz frequency for channel 2

Select Bridge Completion: Allows the host to select the desired bridge configuration

Command Header: [BRDG][n],[x][*]
Parameters: n is the channel number '1' to '32'
x = '0' for full bridge, = '1' for half or quarter bridge
Example: BRDG 1,0 <lf> selects full bridge completion for channel 2

Query Header: [BRDG?][n][*]
Parameters: n with channel number '1' to '32'
Response: x as above
Example: BRDG? 2 <lf>
Example Response: '02,0'<lf> indicates full bridge completion for channel 2

Enable/Disable external shunt resistor: Allows the host to enable or disable an external shunt resistor

Command Header: [SHNT][n],[x][*]
Parameters: n is the channel number '1' to '32'
x = '0' to disable shunt resistor, = '1' to enable shunt resistor
Example: SHNT 1,1 <lf> enables an external shunt resistor for channel 1

Query Header: [SHNT?][n][*]
Parameters: n with channel number '1' to '32'
Response: x as above
Example: SHNT? 1 <lf>
Example Response: '01,1' <lf> indicates shunt resistor enabled for channel 1

Select Excitation Mode and Level: This command allows the host to select both the mode and level of excitation to be applied to the bridge. The range of excitation levels depends on the mode selected.

Command Header: [EXCI][n],[x],[y][*]
Parameters: n is the channel number '1' to '32'
x is the excitation level: 0 to 10 V in 0.25V increments, 0 to 20 mA in 0.5mA increments
y = 'V' for voltage excitation mode, = 'mA' for current excitation mode
Example: EXCI 1,5.0,V <lf> selects voltage excitation of 5.0V

Query Header: [EXCI?][n][*]
Parameters: n with channel number '1' to '32'
Response: x,y as above
Example: EXCI 2 <lf>
Example Response: '01,5.0,v'<lf> indicates voltage excitation of 5.0 volts for channel 1

Select Gauge Factor: Allows the host to select a gauge factor. Since the MT95K2 offers such a wide range of gauge factors (2000 settings ranging from 1.001 to 2071), the host must specify a gauge factor consisting of exactly four digits. For example, for a gauge factor of 2, the host should specify "2.000". If the requested gauge factor is not available, the next closest setting will be substituted. The host is able to query the MT95K2 in order to determine whether the requested gauge factor was available.

Command Header: [GAGE][n],[x][*]
Parameters: n is the channel number '1' to '32'
x is the gauge factor from 1.001 to 2071
Example: GAGE 1,1.003 <lf> selects a gauge factor of 1.003 for channel 1

Query Header: [GAGE?][n][*]
Parameters: n with channel number '1' to '32'
Response: x as above
Example: GAGE? 1 <lf>
Example Response: '01,1.003' <lf> Indicates a gauge factor of 1.003 for channel 1

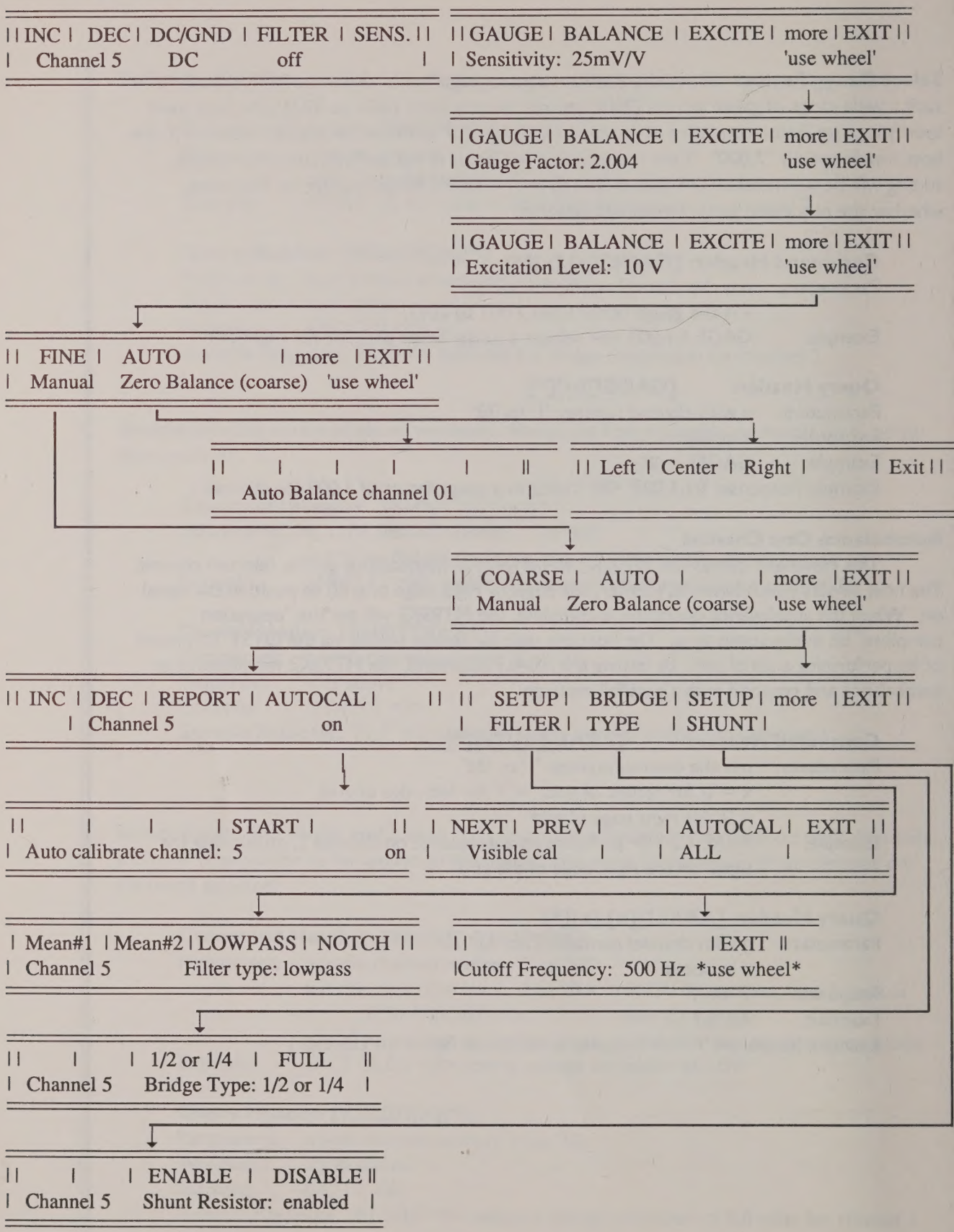
Autobalance One Channel

This command causes the MT95K2 to perform an autobalance on the selected channel. The host selects which baseline, (center, left edge, or right edge of grid) to position the signal on. When the autobalance operation is complete, the MT95K2 will set the "operation complete" bit in the status byte. The host can wait for this by polling via the QYST: command or by performing a serial poll. By issuing the ABAL? command, the MT95K2 will perform an autobalance and respond with a pass/fail message.

Command Header: [ABAL][n], [x][*]
Parameters: n is the channel number '1' to '32'
x = '0' for center of grid, = '1' for left edge of grid,
= '2' for right edge of grid
Example: ABAL 1,2 <lf> performs an autobalance on channel 2, positioning the signal on the right edge of the grid

Query Header: [ABAL?][n],[x][*]
Parameters: n with channel number '1' to '32'
x as above
Response: 'P' or 'F'
Example: ABAL? 1,2 <lf>
Example Response: 'F' <lf> indicates autobalance failure for channel 1

Menu Structure for AWP4 DC Bridge Module for the MT95K2


INC | DEC | DC/GND | FILTER | SENS.
Channel 5 DC off
GAUGE | BALANCE | EXCITE | more | EXIT
Sensitivity: 25mV/V 'use wheel'
GAUGE | BALANCE | EXCITE | more | EXIT
Gauge Factor: 2.004 'use wheel'
GAUGE | BALANCE | EXCITE | more | EXIT
Excitation Level: 10 V 'use wheel'
FINE | AUTO | more | EXIT
Manual Zero Balance (coarse) 'use wheel'
Auto Balance channel 01
Left | Center | Right | Exit
COARSE | AUTO | more | EXIT
Manual Zero Balance (coarse) 'use wheel'
INC | DEC | REPORT | AUTOCAL
Channel 5 on
SETUP | BRIDGE | SETUP | more | EXIT
FILTER | TYPE | SHUNT
START
Auto calibrate channel: 5 on
NEXT | PREV | AUTOCAL | EXIT
Visible cal ALL
Mean#1 | Mean#2 | LOWPASS | NOTCH
Channel 5 Filter type: lowpass
EXIT
Cutoff Frequency: 500 Hz *use wheel*
1/2 or 1/4 | FULL
Channel 5 Bridge Type: 1/2 or 1/4
ENABLE | DISABLE
Channel 5 Shunt Resistor: enabled

Input Type	Isolated, Differential
User Input Connector	10 pin screw terminal connector with a removable plug. This allows the user to wire the transducer to the terminals and then plug into the rear panel of the AWP4
Input Range	Current Excitation: 125 µV/mA to 250 mV/mA Voltage Excitation: 250 µV/V to 500 mV/V
Operating Mode	Peak to Peak only
Input Impedance	Greater than 1 Megohm
Input Coupling	Input of the AWP4 is directly coupled to the differential input amplifier through a single relay
Input Isolation	Input is isolated from chassis up to 250 VDC. Inputs are isolated from each other up to 250VDC. Input isolation means the common of each channel can be at a potential of 250 VDC above chassis ground and/or the other channel on the board. Since the maximum input of the AWP4 is 10 VDC, the signal positive or the differential inputs of the channels should not be exposed to the high voltage unless they are shorted to iso-common.
Maximum Input	Maximum potential between the +signal and - signal differential inputs is 10 VDC or peak AC
Cold Start Drift (Warm up time)	AWP4 requires a 10 minute warm up time to allow the analog circuit to stabilize.
Baseline Drift with Time	Less than 2% of full scale
Baseline Drift with Temperature	Less than 2% of full scale per degree C
Intrinsic Noise	Less than 1% of full scale for sensitivities 1 mV and above. Less than 2% for sensitivities less than 1 mV
Baseline Offset	Less than 1% of full scale
Sensitivity Accuracy	± 1% of full scale
Sensitivity Stability with Time	Less than 0.1% of full scale in 24 hours
Sensitivity Stability with Temperature	0.01% per degree Celsius
Non-Linearity	Less than 0.01%
Frequency Response	With filtering: 1 kHz, without filtering: 5 kHz
A/D Sample Rate	With filtering: 5 kHz, without filtering: 50 kHz
Null Balancing Range	± 5V for coarse and ± half scale for fine
Null Balance Inaccuracy	Less than 1% for coarse, less than 0.1% for fine

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